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EMERGENCY/PROCESS UPSET

FLARING MANAGEMENT:

MODELLING GUIDANCE

Alberta
ENVIRONMENT

EMERGENCY/PROCESS UPSET FLARING MANAGEMENT: MODELLING GUIDANCE

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1.0 Introduction

The primary use of this document is intended for any facility that requires an Environmental Protection and Enhancement Act (EPEA) Approval. However, this document could be adapted and utilised for a wide array of facilities and/or emergency or upset conditions.

In the event of an upset condition in a facility, flaring of large volumes of gas can occur in a short period of time. Designing emergency flare stacks so that the Alberta Ambient Air Quality Guidelines are met can be difficult since parameters such as duration and flow rates will vary depending on the nature of the emergency or upset flaring event.

Furthermore, the shortest averaging time that most models predict for is 1-hour, while often, emergencies or flaring events can be much shorter in duration. Secondly, these emergency or upset flaring events are intermittent. There must be a means to account for the likelihood of whether flaring will occur during a period of worst-case meteorology.

Short-term Alberta Ambient Air Quality Guideline concentrations for SO_2 could be met on a predictive basis if the relationships between the emissions, flaring duration, and ambient concentration were determined for each facility. The relationships of these parameters can be plotted on charts, and made easily accessible to operators, for their use during a flaring event. This would allow them to make appropriate decisions as to when and how flaring will be carried out to meet ambient guidelines by adjustment of the duration, flow, or type of fuel that is being flared.

This document outlines a methodology for dispersion modelling that should be used to determine appropriate flaring management practices. The methodology has been developed to (i) ensure that consistency is maintained in the modelling for each facility. (ii) All facilities are evaluated on the same predictive basis. There are differing scientific views on many methods of modelling, and all facilities are designed differently. However, it is essential that the overall methodology for assessment is consistent to allow for simple comparison between different facilities. There are two levels of modelling methodologies outlined:

- a screening assessment using the SCREEN3 model
- a refined assessment using the ISC3 model

This modelling must be carried out to show that due diligence to protect the environment during upset conditions was considered in any EPEA Application relating to emergency or upset flaring. For further details on dispersion

modelling using these two models in Alberta, please refer to the Final Draft of the Air Quality Model Guidelines.

2.0 Screening Assessment

2.1 Source Parameters

The following parameters must be determined as input into the Screen3 model:

- stack height (m)
- heating value (cal/s)
- emission rate (g/s)

The model assumes a Stack Temperature of 1273K, and an exit velocity of 20m/s.

These parameters will vary with each individual facility, depending on the particular design. The worst case scenario for the facility of interest should be used as a guide for the subsequent analysis.

2.2 Adjustment of Predictions to Shorter-Averaging Times

There are numerous methods to convert a 1-hr predicted concentration. A synopsis of the different methods is presented with an example assuming a 10-minute release. Sakiyama 1984 and Gifford 1975 show some further examples than what is displayed here.

1) Assume that the total gas release occurs over 10-minutes. The gas rate can be divided by 6, and modelled for the entire hour, and the resulting prediction can be directly compared with a one-hour standard.

2) Model as though the gas is released over the entire hour. Assume that the resulting concentration is what would actually occur over a 10-minute interval, for the rest of the hour, the observed concentration would be zero (Once the flare release stops. The resulting prediction from the model can be divided by 6 to obtain the actual 1-hour observed concentration.

Both of these approaches can be shown to be equivalent. This approach, in combination with the SCREEN3 model is recommended to address the impacts of an emergency or upset flare event.

2.3 Screening Level General Methodology

At the screening level, the following assumptions should be made:

- Full Meteorology Option

For further options, please refer to the latest version of the Air Quality Model Guidelines. Given the initial modelling parameters, run the model.

- If the modelling indicates potential exceedances, maximums from each stability class should be closely analysed. If more than (A) stability class exhibits exceedances, higher heating values should be examined, prior to further analysis of the individual stability class maximums.

Adjust the maximum predicted 1-hr concentration, to reflect the duration of the flare by using this equation (See Section 2.2 for supporting information):

Concentration (1hr) = Concentration (Predicted)*duration (seconds)/3600s

E.g. Emission Rate of 50g/s, over 10 min (100% Processing Capacity)
Maximum Predicted Concentration of 5000 $\mu g/m^3$ from model
5000*600/3600 = 833 $\mu g/m^3$ is the hourly predicted concentration.

A variety of concentrations can be calculated using various durations (If flow can be reduced). The new predicted concentration could be much larger than the ambient guideline of 450$\mu g/m^3$ (0.17ppm). If this is the case:

- Run the model again at another heating value (adding lift gas) and determine the results. Adjust the heating value until the guideline is met, or the results are satisfactory within the reasonable bounds of the flaring parameters. If this is not possible, the maximums in each stability class should be analysed.

Analysing maximums in each stability class may indicate that no exceedences occur in all stability classes except for very unstable (A) conditions. The SCREEN3 dispersion model has a tendency to predict large concentrations under these conditions. This is a very rare stability class in most of Alberta (0-2%). If the resultant concentrations are below the guideline value for all stabilities except (A), then no further modelling is necessary, as the likelihood of having an emergency or upset flaring event in combination with (A) stability is low. The conservatism in the model, combined with the low risk of exceeding, is acceptable for design purposes.

If the results are still not below guidelines in other stability classes, a refined assessment should be performed. (See Section 3) Once the screening

assessment is completed, concentration plots should be created as outlined in Figure 1.

3.0 Refined Assessment

If the SCREEN3 model cannot make the appropriate predictions within the guideline value, a refined assessment should be performed using the ISC3 model. The model should use actual meteorological data, in order of this preference:

1) 1 year of site specific meteorological data.
2) 5 years of data from a nearby AES tower.
   (See the latest version of the Air Quality Model Guidelines for details)

Source Information Required:

- Stack Height (m)
- Emission Rate (g/s)
- Temperature (K)
- Exit Velocity (m/s)
- Stack top Diameter (m)

ISC3 does not have the capability to model flares directly, therefore, pseudostack parameters (e.g. height, diameter) should be calculated for the flare, to compensate for the flame height, and initial dispersion from the flame. These parameters can be calculated in a number of different ways. The selected method is left up to the modeller, but must be justifiable. AENV has a spreadsheet that uses the same assumptions as the SCREEN3 model to calculate the pseudo-parameters. It is offered on their web site and is located at:

http://www.gov.ab.ca/env/air/airqual/airmodelling.html

It is called FlrCalcs.exe (In a self-extracting executable, final file is in Excel95/5.0 Format).

The following model options should be used. Detailed AENV recommended methodology on the ISC3 model can be found in the Final Draft of the Air Quality Model Guidelines.

- Terrain data should be utilised as outlined in the latest version of the Air Quality Model Guidelines
- Default Model Options should be selected.
- The same method outlined in Section 2.2 should be used to prorate the results.
- Repeat the process as necessary for other heating values.
- Frequency of exceeding the one-hour guideline should be determined if concentrations are not predicted below the Ambient Air Quality Guideline.

If predictions still exceed guideline values, a more detailed analysis of the high concentrations should be performed. This should include:

- The maximum prediction in each stability class
- Determine wind conditions when high concentrations could occur; and
- A check for a correlation with direction (i.e. Is the mountain to the East of the Facility where all the high concentrations occur)

When the modelling is completed, for the scenario, concentration plots should be generated as outlined in Section 4.0

4.0 Flaring Duration Limits

4.1 Guideline Plots for Various Conditions

Once the modelling is completed, plots for the flaring scenario of the emission rate versus duration should be created. The amount of plots created may vary depending on the nature of the operation. At a minimum, plots for stabilities (B-unstable), (D - neutral), and (E - stable) should be made for the worst-case flaring event. This will be sufficient to give an operator an indication as to how flaring can be conducted. An example of the plots can be found on the next page.

Once these plots are completed, they should be supplied to the operators, along with a description of stability conditions. The operators will then have the ability to assess (see section 4.2 for details), the most appropriate way to carry out the flaring, once health, safety and plant integrity considerations are under control.

4.2 Assessing Stability Class

Stability is a means to parameterise the atmosphere into different "levels" of turbulence. The most commonly used stability categories are the Pasquill-Gifford (P-G) Stability Categories. They range from category (A) very unstable, to category (F) moderately stable. There are different methods in which stability can be calculated, and much will depend on the availability of meteorological data. For many facilities in Alberta, sufficient real-time meteorological data to calculate stability will not be available at the time of an emergency or upset flaring event. Therefore, the operator will have to use his or her own discretion as to what the most appropriate stability class and hence flow rates may be. Table 1 is a broad guide to determining stability class. The table is meant for operational purposes only. It is not a guarantee that the conditions will reflect the state of turbulence in the atmosphere at a particular point in time.

ACID GAS FLARING DURING DIFFERENT STABILITY CONDITIONS

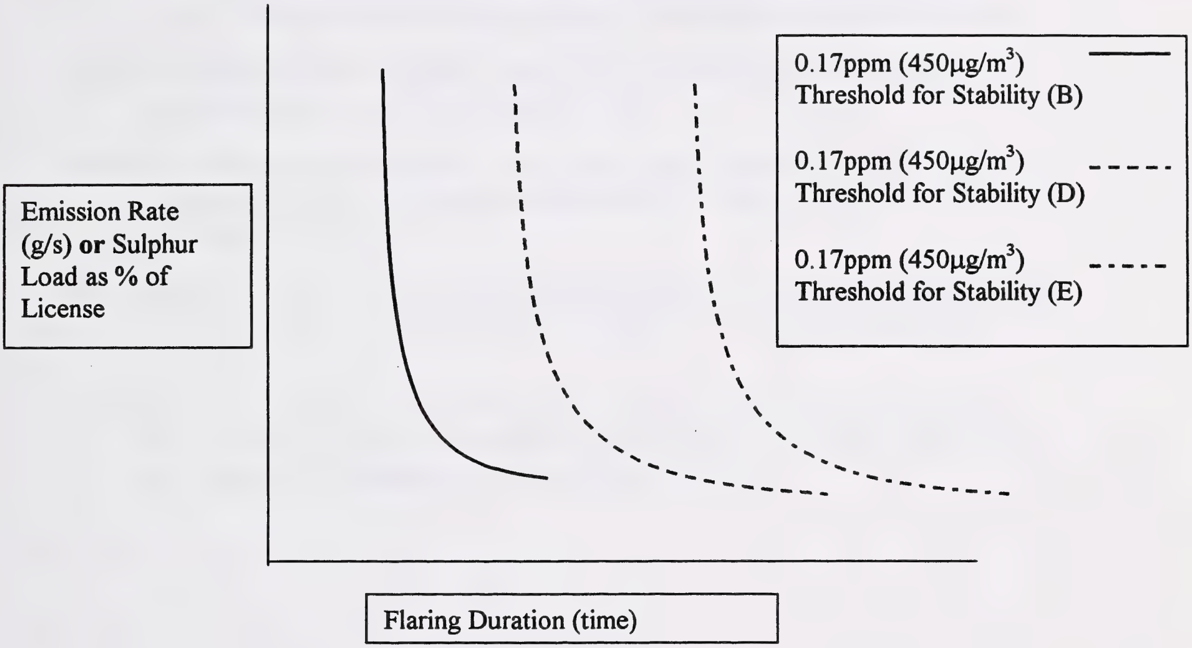

Figure 1 Example Plot: For specific heating value and flaring scenario

Table 1 Broad Guide to Stability

Assumed Stability Class	**General Condition of the Atmosphere**
a) Summer	**(April – September)**
unstable	Relatively Clear Skies, Calm conditions, light winds, during daytime
neutral	Overcast skies (Day or Night-time*) Also for any period with stronger winds
stable	Night-time*, calm to light winds
b) Winter	**(October – March)**
unstable	Unusually warm, clear daytime conditions, light winds
neutral	All overcast conditions, or strong winds (Chinooks included)
stable	Assume for any other condition

*Night-time refers to one-hour before sunset to one-hour after sunrise

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